CARBONCONTAINING SORBENTS FOR PHYTOSORPTION DECONTAMINATION OF SOILS POLLUTED BY RADIONUCLIDES AND HEAVY METALS

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Introduction

Phytosorption decontamination of soil is a promising way for remediation of territories polluted by heavy metals and radionuclides. The main problems to be solved while deciding the possible practical use of this method is the search of the ways of regulating of migration process of metal ions in system soil-solution-plant. It is a known fact that some additives into the soil can be used to increase a mobility of certain metal ions and their bioability for plants.

Carboncontaining adsorbents are successively used for the purification of water and other solutions polluted by radionuclides and ions of heavy metals. Although soils are more difficult to decontaminate from such impurities by sorption techniques, the study of the effect of carboncontaining sorbents on the mobility of metal ions and their transfer into plant available forms is of great interest.

In the present work we present the results of a series of experiments carried out on model and real systems soil-sorbent-plant in order to investigate the influence of sorption additives on migration characteristics of metal ions.

Result and Discussion

As it has been shown earlier the result of the sorbent introduction into the soil may be of two kinds: binding of metals and inhibiting of their migration ability or increase in mobility of ions and their bioability for plants. A number of field experiments conducted by us showed that introduction of mineral sorbents into the soil such as zeolite, palygorskite, vermiculite do not influence practically on the process of radionuclides uptake by plants. The increase in concentration of radionuclides in plants biomass is observed in the case of addition into the soil some quantity of carbon and especially its mixture with zeolite (1:1) (Fig.1).

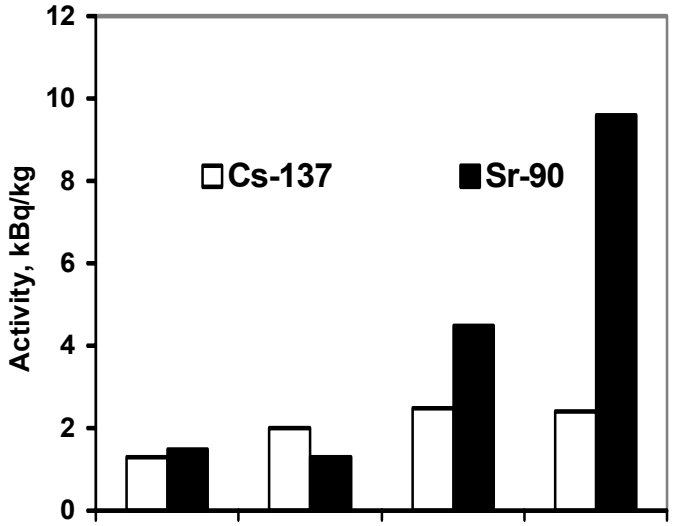

Figure 2. Influence of nature of sorbents on accumulation of radionuclides by plant:1 – Control; 2 – Zeolite; 3 – Carbon; 4 – Carbon + zeolite

In this connection a laboratory research was carried out in order to study sorption ability of these materials towards radionuclides on model systems "radioactive soil- solution-sorbent". The activity of the soil used in the experiments was near 20 Bq/g by Cs^{137}. The systems with the following ratios sorbent / soil = 1:50, 1:25, 1:10 were studied. It was revealed that materials composed of carbon and zeolite maximally adsorb Cs^{137} from the model soil solution (Table 1), decontamination of soil in this case equals 26% for all studied ratios sorbent / soil.

Table 1

Type of sorbent	Maximal decrease of soil activity on application of sorbent		Decrease of soil activity on introducing of 1gramm of sorbent		Real activity of sorbent, kBq/kg (A_s)	$K_1=A_s/A^*_o$
	%	kBq/kg	%	kBq/kg		
Carbon + zeolite (1:1)	26,0	5,2	13	2,6	97,2	4,71
Carbon	17,5	2,7	4,4	0,88	46,2	2,24
Zeolite	10,0	2,0	3	0,6	19,6	0,95

*activity of soil – 20,4 kBq/kg $\rightarrow A_0$

Thus, field and laboratory investigations showed that introduction of carbon-mineral additives into the soil promote desorption of radionuclides from soil mineral and increase their accumulation in plant mass.

Field experiments showed similar influence of above sorbents on transfer of heavy metals in green mass of plants (Fig.2).

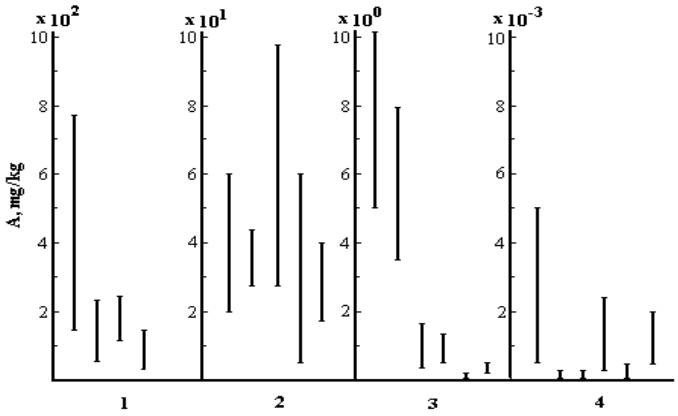

Figure 2. Distribution of microelements in pollen of plants from different ecological zones: 1 – K, Ca, P, Mg; 2 – Na, Zn, Fe, Al, Mn; 3 – B, Cu, Ni, Sr, Li, Pb; 4 – As, Ba, Be, Cd, Co, V

Accumulation ability depends on kind of plants and pollution level of ecological zone. As it is seen from Fig.2, despite the different accumulation ability of plants towards various groups of metals their content in plant pollen varies with change of pollution level of zone. The investigation showed that bioaccumulation of metals such as Na, K, Mg. P by plants decreases with increasing purity of zone and on the contrary accumulation of some heavy metals (Pb, Cu, Zn, As, Cd) in many cases shows an increase exactly in pure zone. A comparison of the relationship between phytoaccumulation and soil pollution for radio-Sr, one- and bivalent metals and ions of heavy metals shows that in the first case symbate dependence takes place whereas for group of heavy metals, on the contrary -antibate.

Of special interest is analysis of morphological changes in pollen structure under the action of accumulated metal ions. It was found that the higher content of heavy metals or Sr in pollen the more abnormal deviations in pollen structure. Analyzing the changes in the structure of pollen using electron microscopy it can be concluded that morphology of pollen can be used as express-test for determination of contamination level of environment.

Conclusion

The possibilities to control accumulation ability of plants through the use of sorption additives into the soil which change the mobility of heavy metals and radionuclides in system soil-sorbent-plant can be used in three perspective directions. First, decontamination of soils; second, the use of plant's pollen as biological sensor for estimation of pollution and decontamination level of the soils; third, usage of combined carbonmineral sorbents and phytosorption approaches for growing of plants with given content of useful components.